Integration of Virtual Map Rooms as a support tool in historical and social research[488]

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Introduction

At the present time almost all map libraries on the Internet are image collections generated by the digitization of early maps. This type of graphics files provides researchers with the possibility of accessing and visualizing historical cartographic information keeping in mind that this information has a degree of quality that depends upon elements such as the accuracy of the digitization process and proprietary constraints (e.g. visualization, resolution downloading options, copyright, use constraints).

In most cases, access to these map libraries is useful only as a first approach and it is not possible to use those maps for scientific work due to the sparse tools available to measure,

488 This research work has been partially funded by DynCoopNet: a cooperative research project of TECT (06-TECT- FP004), a program of EUROCORES approved by the ESF (European Science Foundation). It has also been partially funded by a supplementary action of the R&D Programme 2008-2011 of the Ministry of Science and Innovation of Spain (HUM2007-31128-E).

match, analyze and/or combine those resources with different kinds of cartography.[489] Two such online sources are *The American Geographical Society Library Digital Map Collection*[490] (containing over 500 maps ranging from early maps of Asia to historical maps of Wisconsin and Milwaukee) and the LUNA Browser[491] of the *David Rumsay Map Collection* (which currently contains over 22.000 items online, mainly rare 18th and 19th century maps of North and South America as well as other cartographic materials). These collections allow the user to access and query certain characteristics but they do not provide tools to analyze the maps, much less integrate them in a geographical context. Another relevant online historical content provider is *The World Digital Library*.[492] The WDL makes it possible to discover, study, and enjoy cultural treasures from around the world on a single website. Its cultural treasures include but are not limited to maps. Nevertheless, WDL is once again an interesting data repository in which the opportunity to provide geographic tools was not taken.

More recent applications provide the geographical context but there are not enough tools for getting the most from the maps. A first approach was the Google Maps Rumsey Historical Maps[493] portal of the *David Rumsey Historical Maps* collection. These new

489 Fernández-Wyttenbach, A., Siabato, W., Bernabé-Poveda, M.A., Wachowicz, M.: "Evolution of Digital Map Libraries towards Virtual Map Rooms: new challenges for the historical research", In: *Mapping Different Geographies*, Kriz, K. and Cartwright, W. et al. (Ed. Heidelberg-Germany: Springer Verlag, 2010)

490 The American Geographical Society Library: Digital Map Collection , University of Wisconsin (27/05/2009) <http://www.uwm.edu/Library/digilib/maps/index.html> [04/03/2010].

491 David Rumsey: *David Rumsey Map Collection*, Cartography Associates (21/01/2010) <http://www.davidrumsey.com/view/luna> [23/03/2010].

492 U.S. Libraryof Congress and UNESCO: *The World Digital Library* (WDL) , UNESCO (11/03/2010) <http://www.wdl.org/en/> [23/03/2010].

493 David Rumsey: *David Rumsey Historical Map Collection* , GeoGarage (29/05/2008) <http://rumsey.geogarage.com/> [23/03/2010].

interfaces (Google Maps and Google Earth) allow visualizing the early maps on Google´s globe. This way, it is possible to visualize them georeferenced and to compare them with contemporaneous cartography. One hundred and twenty historical maps have been selected by David Rumsey from his collection of more than 150.000 historical maps to be shown on the Google viewers. This small sample is a good example of how geographic environments can be used for sharing early maps.

One step ahead is The Alexandria Digital Library geographical browser[494]. This interesting geographic approach provides tools for discovering and accessing maps. It offers a rich interface for querying the resources providing up to four different panels of search parameters. The main difference between Alexandria's interface and the Rumsey approach is that the first one comprises a single interface for accessing any map from the collections and it is possible to see more than one resource at the same time. This service is also based on Google Maps in order to provide the geographical context. A comprehensive description of the evolution of Digital Map Libraries (DML) and the most relevant online services, stressing the challenges in the design of the next generation of Virtual Map Rooms, is available in *Evolution of Digital Map Libraries towards Virtual Map Rooms*: new challenges for the historical research492.

But while the Web mapping/visualization tools developed by Google and Microsoft provide very fast, easy-to-access views of images and maps, they are not suited for complex work and analyzes. However, the pervasive use of these new environments

494 The Alexandria Digital Library: *Globetrotter - NGDA Interface* , University of California (16/05/2009) <http://clients.alexandria.ucsb.edu/globetrotter/> [23/03/2010]

offers an opportunity for sharing data and specifically early maps. So, it is evident that it is essential provide users with environments like these but offering enough tools and elements for using early maps properly, not just for seeing them.

Therefore, setting up robust Virtual Map Rooms (VMR) as a tool for supporting historical projects, in which a large number of national and international researches and institutions are involved, means an advance towards avoid the lack of applications that could provide historians and documentary experts with remote access to the existing information from any map library around the world, and also with a set of tools for exploiting and analyzing them. As Dangermond asserted[495], Web-based mapping have been very important and now we are moving from simple mapping and geospatial visualization to full online geoservices. This allows extensive sharing of maps and maps and opens up access to geographic applications to everyone. This, together with the growing availability of georeferenced content and the ability to easily search, discover, and mash up these service, is enabling a whole new pattern and architecture for geographical applications. This pattern emphasizes open and interoperable services that can be used to support a broad array of geographically related applications such as the proposed Virtual Map Rooms. Because of that and following the evolution of the geographic services on the Web, the VMR and tools will be available through one single and usable portal on the Internet.

The proposed VMR facilitates access to digitized resources (restricted and unrestricted) and working with maps located in dif-

495 Dangermond, J.: *GIS and the GeoWeb, ArcNews*, Num.30 ESRI (Summer 2008) 1/21

ferent map libraries all over the world. It also provides a set of tools implemented for the geographical treatment and manipulation of these resources. In addition it simplifies the task of the institutions which are in charge of preserving those archives: optimising human resources, guarding against misappropriations and avoiding direct manipulation of those archives being in a fragile conservation state.

This job is at the same time an instance of how the Geographic Information Technologies may be useful for the professional and research work of historians and social scientists in general, remarkably contributing to the dissemination of the History of Cartography and Cartographic Heritage in the most specialised academic environments.

The paper is structured as follows; part two presents the research context of the project and how a VMR could be useful for historians and researchers in general. Part three describes the implementation of the Virtual Map Room: shows concepts about the data repository, the architecture of the service, the data server and the implementation of a Web client. Part four presents an enriched graphic user interface that contains new tools for interacting with the data repository and maps, including a querying-timeline component for accessing maps easily. Finally, conclusions are presented, and further steps to strengthen the platform implementing other services are discussed.

Research context

It is possible to state that Spatial Data Infrastructures (SDI) are by now a methodological and technological benchmark for publication of the cartographic heritage.[496] The use of the standards

496 Fernández-Wyttenbach, A., Álvarez, M., Bernabé-Poveda, M., Borbinha, J.: Digital Map

and recommendations defined by the Open Geospatial Consortium (OGC) enable accessing to historical-cartographic information with a degree of detail only restricted by the quality of the digitalized documents and associated information issued by each supplier institution.

Thus we underline the high potential of map servers consistent with the OpenGIS standards and specifications, specially *OGC Web Map Service Interface Standard (WMS)*[497], and its capability to set up a platform enabling distributed access to different historical archives. Despite this, it is necessary to be able to find the way for creating and providing the most appropriate virtual tools in order to undertake the usual studies that are being carried out on the old maps by librarians or researchers, either intrinsically on the document or in relation to the real world. This way, metric tools will be available to find out real distances and surfaces among other characteristics and also to make possible analysis that researchers can formulate on the maps (georeferenced documents). In addition to the conventional GIS tools, new ones have been developed to facilitate access to data repositories and manipulation of the results of the queries.

From the beginning it was observed that the appropriate scenario for development and integration of a virtual map room would be within the context of a historical social research project and better if this project would have had international repercussion. Such is the case of the DynCoopNet Project in whose case the need to rely on distributed access of the diverse cartographic archives

Libraries Services in the Spatial Data Infrastructure (SDI) Framework: The Digmap Project. In: *23rd International Conference in Cartography. International Cartographic Association*, Moscow (2007)

497 Open Geospatial Consortium: *OpenGIS® Web Map Server Implementation Specification* 1.3.0, (OGC® 06-042) (J. d. Beaujardiere), OpenGIS® Implementation Specification. Open Geospatial Consortium. (2006)

was recognised.

The aim of DynCoopNet is to provide new theoretical insights about the dynamics of complex systems (the evolution of cooperation tying together the self-organizing commercial networks of the first global age) through the implementation of GIS as data integration engine, fed by distributed databases which store large data sets and information collections, and by using tools for management and discovery of information and tools for temporal analysis and visualization.

It is advisable to develop and setup a Virtual Map Room (VMR) based on open standards and taking into account the mentioned above tools. This VMR will enable historians and researchers from DynCoopNet and other projects to access to the huge amount of information which encompasses the First Global Age and/or any kind of data collections that are available to be shared. Figure 1 shows a snapshot of the proposed VMR.

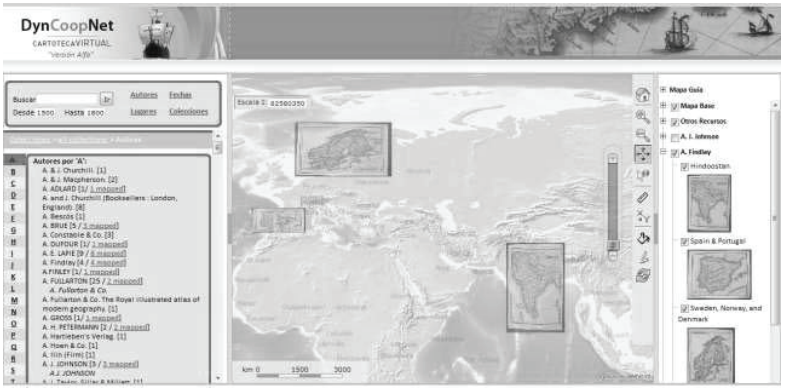


Figure 1. Virtual Map Room of the First Global Age (http://www.dyncoopnet.eu/cartoteca)

Implementation of a Virtual Map Room

The Virtual Map Room has been implemented as a network of cooperating physical servers, providing services, and data via these services. This permits savings in development time, operating costs, and allows for uniformity of data supplier and resources. The organizational structure, operating environment, technical arguments and technological components of this proposal, including the relationships between its parts, and the principles and guidelines, entirely belongs to a typical Spatial Data Infrastructure architecture. This principles are enough robust and mature for sharing any kind of geographic data.

In order to achieve the integration of map libraries and its resources and archives, the team project has setup a virtual space based on Web servers, map servers, CGI and PHP/MapScript support, AJAX support, and other technical elements which provide enough tools and services to offer a rich, robust and reliable VMR. These components have been selected as part of the SDI architecture. The main element is the map server, through which the publishing of geographic and spatial data is feasible. This map server has been recompiled for fulfilling the requirements of researchers, fine tuning the service, and improves performance of OGC specifications.

On the other hand, it has also been designed a specific Web client for enabling access to the DIGMAP[498] search engine and to the old cartography repository. This Web client, which is a online interface, synchronises the search engine with a geographic

498 DIGMAP: *Discovering our Past World with Digitised Maps* (Programme eContentplus – Project: ECP- 2005-CULT-038042) (16 /10/2009) <http://www.digmap.eu> [23/03/2010]

browser that allows carrying out geographic browsing and querying operations once the searching process has been done.

The software platform of the project is based on Open Source projects both in the server and client side; most of them using the GNU General Public License which allows to use, change and share the software and secondary applications without restrictions and making sure it remains free software for all its users. This means the proposed framework is also under the GNU GPL.

Historical data repository

The information used in the test and implementation processes has been provided by DIGMAP - an online repository of historical-cartographic documents. This portal is the outcome of a European project co-funded by the Community programme eContentplus and published on November 2008.[499] The aim of DIGMAP was to turn its portal into the international reference gateway to old maps and related bibliography. The project proposed the development of solutions for digital libraries especially focused on cartography that promotes the cultural and scientific heritage.[500]

This project provides easy access to the thousands of early maps of national libraries and collections around the world through the Internet. This possibility is undoubtedly useful for the creation of a virtual map room that aims to provide information for historical and social research interests, since it allows massive

499 DIGMAP: Discovering our Past World with Digitised Maps (Programme eContentplus – Project: ECP- 2005-CULT-038042) (16 /10/2009) <http://www.digmap.eu> [23/03/2010]

500 Borbinha, J., Pedrosa, G., Gil, J., Martins, B., Freire, N., Dobreva, M., Fernández-Wyttenbach, A.: Digital Libraries and Digitised Maps: An Early Overview of the DIGMAP Project. In: *Asian Digital Libraries:Looking Back 10 Years and Forging New Frontiers. LNCS,* vol. 4822, Goh, D.H.L., Cao, T.H., Sølvberg, I., Rasmussen, E. (Ed.) pp. 383-6. (Springer, 2007)

access to a huge amount of cartographic information and related documents, no matter where it is stored. The main service is a specialised digital library which recovers metadata from European national libraries and offers online map searching and access to the contents. Metadata from other sources are also reused as well as descriptions and references to other relevant external resources[501/502]

It is important to stress that DIGMAP is a virtual digital library, in the sense that it holds only the metadata that describes the resources, but not the resources themselves, what remain in the local libraries or Web sites (It means that the VMR access the original resources through these metadata). The resources also can be (i) digital-born, (ii) digitized, or even (iii) physical resources existing only in the shelves of the libraries. When the resources are digitized maps, it is possible to index them by their geographic boundaries.

Independent of its technical and technological contributions, this is the real added value of the DIGMAP Portal as data engine for the development of virtual map rooms, the large amount of digital maps that has previously been indexed and georeferenced. This characteristic allows to the geographic browser shows the map in the right position when the resource is queryable, in other words, when the resource is georeferenced, otherwise it won´t be possible to show the map on the geographic browser.

501 Pedrosa, G., Luzio, J., Manguinhas, H., Martins, B., Borbinha, J.: DIGMAP: A Digital Library Reusing Metadata of Old Maps and Enriching It with Geographic Information. In: *Research and Advanced Technology for Digital Libraries. LNCS*, vol. 5173, Christensen-Dalsgaard, B., Castelli, D., Ammitzboll Jurik, B., Lippincott, J. (Ed.) pp. 434-5. (Springer, 2008)

502 Martins, B., Manguinhas, H., Borbinha, J., Siabato, W.: A geo-temporal information extraction service for processing descriptive metadata in digital libraries. In: *e-Perimetron. International Web Journal on Sciences and Technologies Affined to History Of Cartography,* vol. 4, no. 1, pp. 25-37. (Thessalonica, 2009)

Figure 2 shows the georeferencing process in the *DIGMAP Geographic Index module.* It should be noted that the geographic referencing process in DIGMAP is not high-accurate and it just supplies an approximate location of the maps based on the maximum and minimum coordinates of a bounding box. This reduces the accuracy of measurements and operations on the map. Nonetheless it is valid enough as a first approximation. There are methods that deal with the geometric and projective characteristics and properties of early cartographic representations[503/504] that could be taken into account in the future in order to improve this weakness for online resources.

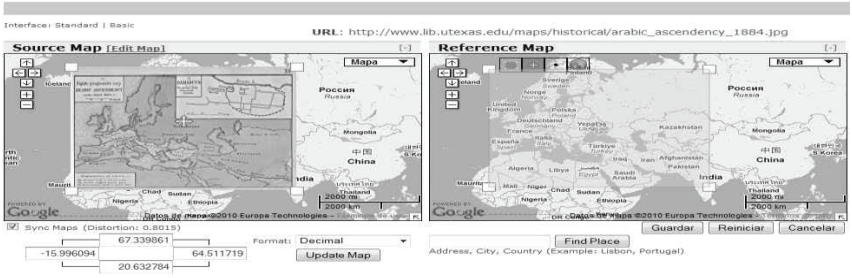


Figure 2. Geographical indexing of historical contents in DIGMAP

However, the geographic browsing tools associated to the DIGMAP search engine are excessively simple and do not follow the appropriate usability criteria.[505] For this reason, it is necessary to

503 Livieratos, E.: On the Study of the Geometric Properties of Historical Cartographic Representations. In: *Cartographica*, vol. 41,no. 2, pp. 165-75. (2006)

504 Boutoura C., Livieratos. E.: Some fundamentals for the study of the geometry of early maps by comparative methods. In: *e-Perimetron. International Web Journal on Sciences and Technologies Affined to History Of Cartography*, vol. 1, no. 1, pp. 60-70. (Thessalonica, 2006)

505 Fernández-Wyttenbach, A., Moya-Honduvilla, J., Álvarez, M., Bernabé-Poveda, M.: First approaches to the usability of Digital Map Libraries. In: *e-Perimetron: International Web Journal on Sciences and Technologies Affined to History Of Cartography,* vol. 3, no. 2, pp. 63-76. (Thessalonica, 2009)

develop a new interface that allows researchers to access this huge collection easier than now and use the maps in a better way.

So that this interface could be really useful and assure system interoperability, it has been chosen to incorporate to the virtual map room the basic concepts of the SDI reference framework. Thus the results (maps and documents) are presented on a web-mapping framework in accordance with the usual OGC services, providing cartographic information using independent layers, assuring process and platform compatibility, and therefore, making easier the documentary research for librarians, historians and other researchers. The next sections describe the server and client processes.

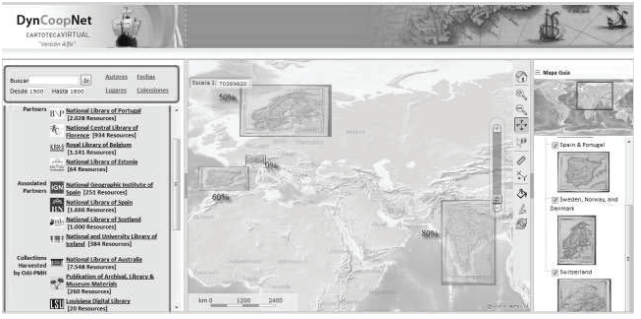


Figure 3. Synchronisation of results combined with the transparency function

Geographic data server

After having identified the characteristics of the data repository, and knowing the benefits and disadvantages of

geographic servers available currently on the market[506/507/508], the geographic data server MapServer (http://mapserver.org) has been chosen as the most appropriate option for management and publishing of cartographic and historical information. This server offers enough quality, reliability and functionality for sharing data on the Internet. It supports display and querying of hundreds of cartographic data sources and formats, rendering and showing them using different reference systems and projections through the on-the-fly projection capabilities. In addition, it assures high quality rendering. These characteristics are very useful for the integration of early maps, WMS data layers and other cartographic resources. For instance, transparency and antialiasing properties are quite efficient for showing early cartography on a reference WMS layer as shown in Figure 3.

MapServer is a general platform for publishing spatial data and other geographic applications to the Web. Based on the language ANSI C/C++, it may be executed, configured and customised in a large number of operative systems and environments. This means that the framework developed on this proposal can run almost on any platform configuration of any map library. Also, MapServer holds external libraries allowing its extensibility and supports many raster, vector and database formats. This characteristic proves essential when accessing, extracting and serving data from different historical data repositories, such as the ones described above in the DIGMAP Project.

506 Jansen, M. 2009, 'Comparing apples and oranges: Uncovering the mystery of component selection in WebGIS projects', in *FOSS4G 2009*, Sidney - Australia.
507 Aime, A. & McKenna, J. 2009, 'Web Mapping Performance Shoot-out', in *FOSS4G 2009*, Sidney - Australia.
508 Aime, A. 2009, 'GeoServer in Production', in *FOSS4G 2009*, Sidney - Australia.

The flexibility of using that the server offers through the exchange of parameters using conventional HTTP request methods, GET and POST, allows to dynamically configure the appropriate variables to meet the specific needs of a particular user at a given instant. It thus solves the drawback of generating maps using a static configuration file which does not allow modifications by external users. Due to the development characteristics of the DIGMAP components in which the message interchange is handled through this technique, MapServer is a candidate that covers interaction with the historical contents of the map libraries and other future collections that someone wants to integrate.

This way and from a technical point of view, it is possible extract the information and visualizes it on the client by means of parameterized URL query strings. On one hand, the geoinformation is extracted from the historical documentation repositories to generate a raster file as a result, and on the other hand, a text file with additional information is also obtained for subsequent georeferencing process. The generated information is accessible from a temporal URL that points to a public directory of the Web server in which MapServer is executed as a Common Gateway Interface application (CGI). Thus, the server has available the image and the information required for georeferencing.

Once the access to the repository data has been solved and the platform has been defined, next step is to visualize the information and to offer users (librarians, historians, researchers) the necessary tools[509/510] to be able to interact with the identified

509 Saracevic, T.: 'Digital library evaluation: Toward evolution of concepts', In: *Library trends*, vol. 49, no. 2, pp. 350-69. (2000).

510 Marchionini, G., Plaisant, C., Komlodi, A.: The people in digital libraries: Multifaceted approaches to assessing needs and impact, In: *Digital library use: Social practice in design and evaluation*, A.

resources.

Service architecture scheme

The typical application flow for data services based on MapServer is diagrammed in Figure 4. The basic architecture of MapServer applications contains a MapFile, Geographic Data, HTML Pages, MapServer CGI application and the HTTP Server. The MapFile is a structured text configuration file that defines where the data is and where to output the generated images. It also defines map layers, including their data source, projections, and symbology. Through these elements we can define sources for early cartography and load them.

These sources define the second element of the basic architecture: Geographic Data. The geographic server supports several data input formats by default, but in our case we have compiled it with the open source libraries GDAL and OGR in order to get more formats and offer a higher quality images. For this service, we are using WMS layers, Shape File format and support for Alpha channel through AGG driver. This way, we ensure the application can read and load any file from any library or data source.

HTML Pages is probably the main element because it's the interface between the user and MapServer. This item is fully provided by the p.mapper framework, thus it's possible to focus only on the data and functionality. The MapServer CGI application and the HTTP Server are the core of the systems. The CGI is an

Bishop, N. van House , B. Buttenfield (Ed.). 119-60, MIT Press, (2003).

executable file that receives requests and returns images, data, and other elements which are used by the HTTP Server for serving up the html pages when the user (researchers) hits the browser. For this case, the VMR is supported by Apache 2 HTTP Server.

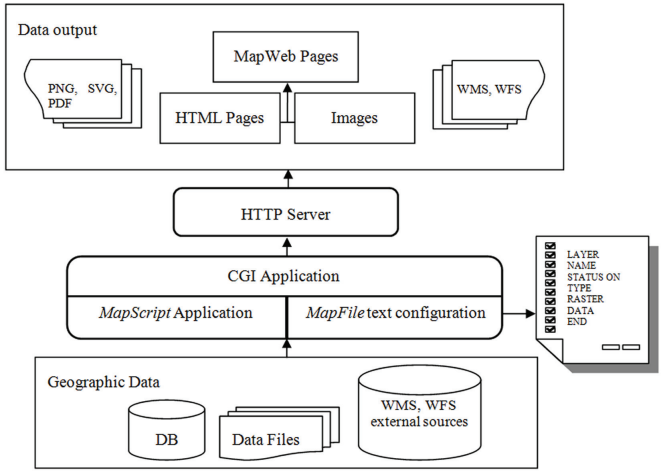
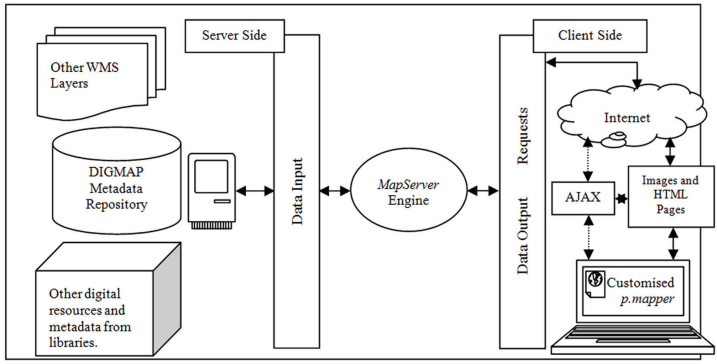


Figure 4. Typical application flow of MapServer

Based on Figure 4, it's quite easy to describe data flow of the VMR. In brief, MapServer gets the resources through the DIGMAP collection by URL requests, and displays them on the Web client (p.mapper).



The early cartography Web client

To interact with the queried resources it is necessary to rely on a stable and functional interface which suits for the purpose of a virtual map room. Taking into account that currently on the market there is a large supply of robust and high-performance thin-client web-mapping frameworks, it was decided to build our proposal based on these clients and not to develop a new one from scratch since most of them comply with the minimum historians' requirements[511] to interact with old cartography. Among the desirable selection criteria should be emphasized: software license, programming language, model and structure, ease of customisation, language used by the API or application interface, OGC services that supports, dependence on the map server, inclusion of metadata components, interoperability and usability of its tools and perhaps most relevant, an Open Source framework for its easy adaptability to specific needs.

511 Crespo Sanz, A.: The atlas of El Escorial, a forgotten map, *Boletín de la Real Sociedad Geográfica* Num.CXLV Royal Geographical Society of Spain (2009) 117-142.

After having analyzed the available options, it was decided that the visualisation framework best fitting the specific needs of map libraries is p.mapper (http://www.pmapper.net). p.mapper is a thin Web client which offers wide range of functionality and multiple options for facilitating the configuration and installation of applications based on MapServer and PHP/MapScript. It works following the multi-layer model and the client-server architecture which suits perfectly for geospatial data visualisation and its manipulation through basic browsing and querying tools. As we said above, it is characterized by using the *GNU General Public Licence* which ensures being able to modify the application and redistribute it without restrictions. On the other hand, it relies on a modular programming structure favouring the development and incorporation of new functionalities or modification of the existing ones, according to requirements. In addition to the characteristics already mentioned, p.mapper is programmed under de object-oriented programming paradigm, so useful for increasing functionality without modify the original structure.

As a thin client, p.mapper takes advantage of the last advances in Web technologies such as AJAX, enabling transfer of data from client to server and return of results asynchronously, updating information for the client without having to reload the website. This functionality is exploited to achieve a more natural and intuitive interaction with early maps. In addition, p.mapper supports several relational DBMS and contains JavaScript libraries that facilitate the programmer's task when it needs to update functionalities or create new ones. It handles the light format for data interchange JSON that minimises the bandwidth expended in

client-server communications, with the consequent increment in response time and speed.

This way, we have used *MapServer and p.mapper* for providing access to historicalcartographic archives through a graphical Web interface. Linux Debian OS and the Web server Apache2 with the PHP5 as scripting language were used as server operating platform; on the client side, usual Web mechanism such as JavaScript (language script), Cascading Style Sheets (layout presentation) and XML (configuration) were used. As we said above, communication between server and client has been established through AJAX to provide natural interaction with maps. These tools allow any user access to data, regardless their choice of computer, software, browser or other specifications.

The results and performance obtained so far are reliable and the tests carried out indicate that this framework has been a good choice, especially for developing new specific tools for old cartography and integrating with the DIGMAP data repository.

Enriched graphic user interface

In order to offer historians and researchers an intuitive interface for accessing and querying maps; we have improved the client-framework developing new tools and functionalities. The framework has a flexible layout structure for including new elements into it through frame windows. There are some frames that remain empty, and which can be used for almost any task if the right techniques are applied. We have used these frames for including the DIGMAP engine and other external applications

that provide users with a single graphic interface for searching, querying and browsing data.

Due to the DIGMAP metadata repository had been already connected, it was necessary to synchronize both the data engine and the framework. This job was done using session variables. Through this method, we have achieved what we wanted to: incorporate metadata and data naturally so that user could manipulate them easily.

It is easy to check when the synchronization process has been done, once it has finished a new Table of Contents (TOC) is loaded in the browser. This new TOC shows the footprints of the available georeferenced sources, it must be kept in mind that not all the metadata records contain indexed geospatial sources. Figure 6 shows a customized TOC.

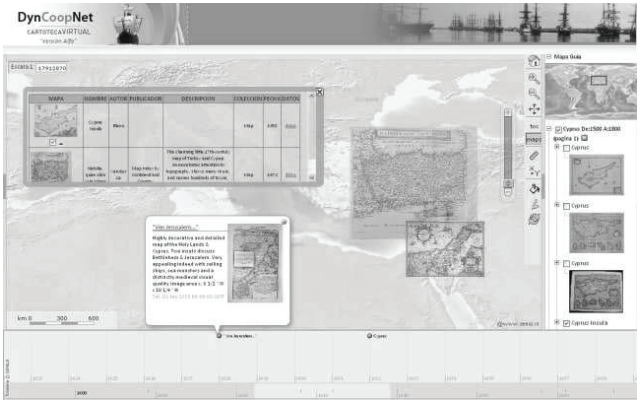


Figure 6. VMR customised functions for early cartography

Once the metadata have been loaded it is possible to describe the queried map. For this aim, there is a specific tool that loads and shows the information by clicking on the map. After this, a table describing maps is showed. This table contains a link to the original resource and a further description. Transparency properties are also been handled for this table in order not to vanish the geographic information. Finally, when user needs to change parameters or make new queries without taking into account the previous ones, it is possible to reset the client and delete the metadata and data previously loaded. A single gray X posted in the TOC will delete the current map.

Another useful tool is the incorporation of a temporal-line browsing synchronized with text searches on the catalogue and the geographic browser. This tool is based on The SIMILE© Project Timeline widget (http://www.simile-widgets.org/timeline). At the same way as we used an empty frame for including the DIGMAP engine, we have used a bottom-frame available in the p.mapper's layout. This tool is useful for knowing the main description of the map and better than this, to show an overall view of the maps in a single timeline. Through this tool, researchers will be able to query just the maps they really need independent of searching criteria locating them by date. It works as a complement for the searching that the user has previously done.

All these tools could be improved but offer a new way for interacting with early maps. Some new tools have been developed but it will be available at near-future. Next section describes some of these future tools and presents conclusions.

Conclusions and future advances

Virtual Map Rooms are tools of high interest for historical and social research projects. They provide specialised access to distributed cartographic collections and especially early maps collections. The success and sustainability of these tools will be influenced by their design and usability patterns; this shall be carried out according to the criteria of publishing of geographic information issued by SDI specifications. They are at the same time an instance of how the Geographic Information Technologies may be useful for the professional and research work of historians and social scientists in general, remarkably contributing to the dissemination of the History of Cartography and Cartographic Heritage in the most specialised academic environments.

This project has provided a Web-mapping application developed in order to supply valuable and comprehensive instruments for both representing and promoting the knowledge of cartographic heritage to a large number of people. As far as the application has been developed, the result is a web-mapping portal accessible directly from the Internet that makes historical-cartographic resources available for everybody. In this sense, some task for the internationalization of the project has been done but not enough for providing universal access. Some characteristics that cover this aspect will be included at near-future.

As a Web mapping platform, the VMR brings together the SDI Architecture into a single, easyto- use Web Portal that provides access to historical data repositories. Any data repository can be included in this portal; also any library which provides access to its digital contents through the DIGMAP Architecture will be part

of the proposed VMR automatically. It is the fastest way to provide access to the cartographic heritage on the web, leveraging the power of some of the best open source geospatial platform and the biggest repository of historic-cartographic data on the Internet.

Despite the existing proposals, the Virtual Map Room proposed on this paper is the biggest georeferenced historical-cartographic map collection on the Internet. This is due to the fact that the application uses the DIGMAP metadata repository, which provides access to over 2500 georeferenced historical maps. Unlike other collections that provide access to 150 georeferenced digital maps through *The David Rumsey Map Collection* and 300 in the case of The World Digital Library. In this sense, the VMR provides access up to eight times more than the other prestigious collections. However, it must be highlighted the quality of the maps. Although these collections offer few maps, they maintain a high degree of quality. Actually, the georeferencing process in these collections is a lot better than the one done in the DIGMAP engine, especially on the Rumsey collection.

If one compares digital access to georeferenced early maps, using web-mapping interfaces, will find that the tools available on the VMR are quite useful, intuitive and usable. The server has been setup for completeness, reliability and availability. The VRM relies on the SDI architecture foundations. This job has supplied a supported web mapping platform for larger configurations related with early cartography. Finally, we have added key components that simplify and enhance the user experience and support the work of libraries in charge of preserving cartographic archives.

This project will include at near-future some significant improvements into the Virtual Map Room by giving new technical

and conceptual contributions that will enhance its usability according to users' requirements. To that end, it is necessary to address the following issues:

(i) Incorporation of semantic and spatio-temporal components. These components play an important role to complement the research work carried out within the proposed platform. The presentation and implementation of them in a coordinated fashion will mean a considerable advance in the initial management of the information and will lead to a substantial change in the search habits that historians and researchers are used to.

(ii) Quality of the contents. It mustn't be lost sight of that the Virtual Map Room cannot be responsible for the quality of the information accessed. So it is not uncommon to find out that there are still collections without georeferenced archives or very poor descriptions (metadata). However it is important to highlight that the application is capable of automatically incorporating all the improvements that this contents can take in the future, as well as new catalogues or collections. It is necessary to incorporate tools that allow the user to check quality and reliability of the resources. Also, it would be useful to improve the georeferencing engine provided by DIGMAP.